CNT Interconnects

Limitations of Copper Interconnects

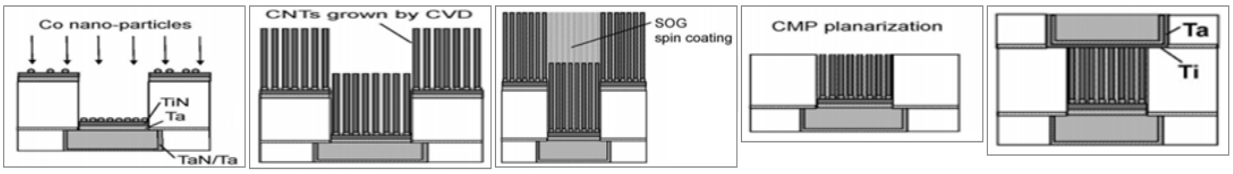
- Increasing size leads to
  - Increased Resistance which causes increased delay.
  - Increased current density which causes electromigration.

Types of CNT Structure

- Single-Walled → diameter = 0.4 ~ 1 nm
- Multi-Walled → diameter = 5 ~ 100 nm

Fabrication

1- Cobalt Deposition.
2- CNTs Growth.
3- SOG Coating.
4- CMP.
5- Contact Layer.



(1) **(2)** **(3)** **(4)** **(5)**

Electrical and Thermal Properties

- CNT can withstand high temp due to strong atomic bond.
- Resistance decreases by increasing the fabrication temperature.
- High thermal conductivity.
- In short Vias
  - Resistance is independent on temperature.
  - CNT is strong enough to withstand high current density.

Mechanical Properties

- Very strong
- Elastic

CNT vs. Delay

CNT Setup	Resistance	Capacitance	Delay "t_d=RC"
Isolated CNT	Increased	Same	Increased
Flat Array CNT	Decreased	Increased	Same
Bundle CNT	Decreased	Same	Decreased ✓

- **Bundle CNT** is the best setup due to reduced delay.

Performance Analysis "CNT vs. Copper"

- **Delay**

"Interconnect to use for lower Delay"		
	Length	**Interconnects**
Local	0 ~ 1 µm	Copper
Intermediate	1 ~ 100 µm	CNT
Global	100 ~ 1000 µm	CNT

- **Electromigration**
  - CNT interconnects has longer electromigration lifetime.
  - Copper interconnects shows deteriorated electromigration.

CNT Interconnects Advantages

- Better electromigration over time.
- Lower delay for global interconnects.

CNT Interconnects Disadvantages

- No performance improvement in local interconnects
- Complex fabrication process